

WHAT IS CLAIMED IS:

1                   1.     A flexible microchannel heat exchanger, comprising:  
2                   a device interface layer including inlet and outlet holes and being  
3     formed from a first heat-sealable polyimide material;  
4                   a header layer formed from a second heat-sealable polyimide  
5     material and heat-sealed to said device interface layer, said header layer including  
6     ports aligned with said inlet and outlet holes and fluid distribution microchannels  
7     in fluid communication with said ports;  
8                   a channel layer formed from said second heat-sealable polyimide  
9     material and heat-sealed to said header layer, said channel layer including fluid  
10    flow microchannels in fluid communication with said fluid distribution channels  
11    and oriented differently than said fluid distribution channels; and  
12                  a cap layer formed from said first heat-sealable polyimide material  
13    and heat sealed to said channel layer.

1                   2.     The heat exchanger of claim 1, wherein said first heat-  
2     sealable polyimide material has a greater glass transition temperature than said  
3     second heat-sealable polyimide material.

1                   3.     The heat exchanger of claim 2, wherein said first heat-  
2     sealable polyimide material includes a core having said greater glass transition  
3     temperature.

1                   4.     The heat exchanger of claim 1, wherein:  
2                   said first heat-sealable polyimide material is DuPont Kapton® EKJ;  
3     and  
4                   said second heat sealable polyimide material is DuPont Kapton® KJ.

1                    5.     The heat exchanger of claim 1, wherein the microchannels in  
2     said channel layer have a plurality of lengths.

1                    6.     The heat exchanger of claim 5, wherein the microchannels in  
2     said channel layer have an overall hourglass-like shape, and a waist of the  
3     hourglass-like shape aligns with said ports in said header layer.

1                    7.     The heat exchanger of claim 1, wherein fluid communication  
2     between microchannels in said header layer and said channel layer is established  
3     where ends of microchannels in said channel layer intersect microchannels in said  
4     header layer.

1                    8.     The heat exchanger of claim 7, wherein microchannels or sets  
2     of microchannels in said channel layer further from said ports intersect more  
3     microchannels in said header layer than microchannels or sets of microchannels in  
4     said channel layer that are closer to said ports.

1                    9.     The heat exchanger of claim 1, wherein said header and  
2     channel layers are thicker than said device interface and cap layers.

1                    10.    A flexible microchannel heat exchanger, comprising:  
2                    a laminated polyimide structure including a device interface layer, a  
3     header layer, a channel layer and a cap layer; and  
4                    a three-dimensional microchannel fluid circuit formed by  
5     microchannels in said header layer and said channel layer and holes in said device  
6     interface layer, wherein intersections of microchannels between said header layer  
7     and said channel layer define flow paths between said header layer and said  
8     channel layer.

1           11. The heat exchanger of claim 10, wherein microchannels or  
2 sets of microchannels in said channel layer further from said holes intersect more  
3 microchannels in said header layer than microchannels or sets of microchannels in  
4 said channel layer that are closer to said holes.

1           12. A method for forming a flexible microchannel heat  
2 exchanger, the method comprising steps of:  
3           mechanically patterning heat-sealable polyimide sheets to define  
4 separate device interface, header, channel layers;  
5           preparing the patterned sheets for lamination bonding; and  
6           laminating the patterned sheets together with a cap layer.

1           13. The method for forming according to claim 12, further  
2 comprising a step of cutting the heat-sealable polyimide sheets to size prior to said  
3 step of mechanically patterning.

1           14. The method for forming according to claim 12, wherein said  
2 step of mechanically patterning comprises a computer controlled knife cutting.

1           15. The method for forming according to claim 14, wherein said  
2 computer controlled knife cutting is conducted according to a three-dimensional  
3 solid model.

1           16. The method for forming according to claim 12, further  
2 comprising a step of mounting the sheets on a carrier prior to said step of  
3 mechanically patterning.

1           17. The method for forming according to claim 12, wherein said  
2 step of laminating comprises vacuum hot-pressing.

1                   18.    The method for forming according to claim 17, wherein the  
2   cap layer and the device interface layer are formed from a higher glass transition  
3   temperature polyimide than the header layer and the channel layer

1                   19.    The method for forming according to claim 17, further  
2   comprising a step of applying a platen separator to the cap layer and the device  
3   interlayer prior to said step of lamination.

1                   20.    The method for forming according to claim 12, wherein said  
2   step of preparing comprises solvent degreasing.

1                   21.    The method for forming according to claim 20, wherein said  
2   step of preparing further comprises scrubbing.

1                   22.    The method for forming according to claim 21, wherein said  
2   step of preparing further comprises rinsing.

1                   23.    The method for forming according to claim 21, wherein said  
2   step of preparing further comprises drying.

1                   24.    The method for forming according to claim 23, wherein said  
2   step of preparing further comprises dehydrating.